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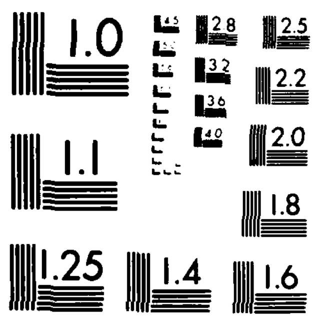

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FOREIGN TECHNOLOGY DIVISION

LOCAL TELECOMMUNICATION CABLE WITH INSULATION LAYERS AND POLYETHYLENE JACKET

by

Tadeusz Lapinski

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Local Telecommunications Cable with Insulation Layers and a Polyethylene Jacket

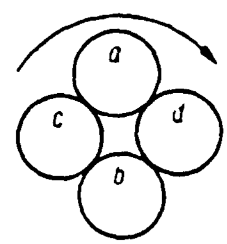
Tadeusz Lapiński, MS

With the intention of the maximum use of production machinery and equipment, the Cable Factory in Ożarowa in Mazuria started up the production of local telecommunication cable with layers of insulation and a polyethylene jacket having an antimoisture shield. The cable is produced with a number of quads: 5, 10, 15, 25, 35, and 50, with conducting wires having a diameter of 0.8 mm. In order to distinguish this cable from multi-tube cable, it is designated with the symbol XTKMpX.

Local cable of the XTKMpX type is specified for being laid in cable channels and directly in the ground over terrain that presents only small possibility of mechanical damage. It can be laid or installed at ambient temperatures not lower than -30°C.

The cable wire conductors are made of soft copper wire with diameters of 0.8 mm. Lightweight polyethylene insulation with a thickness of 0.23 mm is die stamped on the conductor wires. The insulated conductors are braided into star-quads, with appropriately chosen twist lengths assuring only small values for capacitance unbalance (k_1 and k_{9-12}). The twist lengths for the quads do not exceed 120 mm. Denotations for the core conductor wires in a quad bundle are shown in the figure. Transmission pairs are formed by conductor "a" and "b," and "c" and "d."

The quads are braided in layers into a core with the structures shown in Table 1.



The quads in the core and in the individual layers are distinguished among themselves according to whether they are counter quads, command quads, unpaired quads, or paired quads. The insulation colors for the conductor wires in the

Table 1. Number of quads in the core and in the layers

No. of quads in a cable	Number of quads in the core and in the layers			
	Core	Layer number		
		1	2	3
5	5			
10	2	8		
15	4	11		
25	3	8	14	
35	5	12	18	
50	5	9	15	23

quads named here are given in Table 2.

Table 2. Code for telling apart the conductor wires in the quads and the quads in the core

Type of quad	"a"	"b"	"c"	"d"
counter	red	green	natural	natural
command	blue	green	natural	natural
unpaired	yellow	green	natural	natural
paired	bronze	green	natural	natural

Multiquad cores in successive layers are covered with a strip of colored thread or colored tape with a twist length not exceeding 120 mm. The colors of these coverings, depending on the layer, are the following: red, for the core; blue, for the first layer; yellow, for the second layer; and bronze, for the third layer.

The direction for numbering the quads in the core and in the individual layers at the external end of the cable is identical and clockwise.

One or more polyester strips, in the form of a winding or a lengthwise covering, are placed on the cable core, and the exterior lap of the strip is equal to at least 10% the width of the strip, but not more than 4 mm.

In turn, an antimoisure barrier deposited lengthwise along the lap is applied to the insulated cores; it is made of aluminum foil, with a thickness of

at least 0.08 mm, coated on one or two sides by a layer of a copolymer of ethylene. The size of the lap is at least 3 mm -- for cable with a core diameter not greater than 11 mm, and 5 mm for cable with a core diameter not greater than 22 mm, and 7 mm for all other cable. The lap along the entire length is tightly connected. The surface of the aluminum foil coated with an ethylene copolymer runs consistently along the external side of the tube. In the case of an antimoisture barrier coated on only one side with the copolymer, a conducting wire runs lengthwise under the uncoated surface, acting as a ground and made of tinned copper, with a diameter of 0.5 mm.

A jacket made of lightweight polyethylene with an additive of carbon black is die stamped onto the antimoisture barrier. The interior surface of the polyethylene jacket is in contact with the copolymer layer covering the aluminum foil on the antimoisture barrier.

The number of quads in cable of the XTKMpX type, jacket thicknesses, core diameters, exterior diameters of the cable, and allowable loading forces for the cables are given in Table 3.

Table 3. Geometrical dimensions of cable elements

Cable designation	No. of quads	Conducting wires Ø (mm)	Insulated con. wires Ø (mm)	Quad diameter (mm)	Core diameter (mm)	Tkns polyethylene jacket (mm)	Exterior cable Ø (mm)	Max. loading forces (daN)
XTKMpX	5	0,8	1,3	3,2	8,0	1,5	11,5	80
	10	0,8	1,3	3,2	12,0	1,5	15,5	140
	15	0,8	1,3	3,2	13,0	1,5	16,5	210
	25	0,8	1,3	3,2	18,0	1,6	22,0	350
	35	0,8	1,3	3,2	20,0	1,6	24,0	490
	50	0,8	1,3	3,2	24,0	1,8	28,5	600

[Ø = diameter]

Allowable bending radii for the cables is 10 exterior diameters for these cables.

The length of prepared cable segments is 600 m, and allowable deviations from the fixed length do not exceed 1%. All cable has a producer's stamp, including an alpha symbol for the cable, the manufacturer's name, and the year of

manufacture, stamped in relief on the jacket and legible. The distance between the end and the beginning of adjacent marks does not exceed 50 cm.

Manufactured cable segments are to be finished off with a hermetic seal using caps made of elastomers or plastics, or else in any other manner guaranteeing a hermetic seal for the cable.

Resistance for the core conducting wires in finished cable, measured with direct current, at a temperature of 20°C, should not exceed 38.7 Ω/km. In practice, the average value for the resistance of one loop of core conducting wire should fall within the range from 69.1 to 70.1 Ω/km, and the maximum value for the resistance of a loop of core conducting wire should not exceed 71.3 Ω/km.

Resistances measured at other temperatures lower than 20°C should be converted to the resistance value at a temperature of 20°C according to the following formula:

$$R_{20} = R_t \cdot K,$$

where:

R_{20} -- resistance of core conductors at 20°C,

R_t -- resistance of core conductors at temperature t°C,

K -- conversion factor.

The conversion factor for a resistance (K) is expressed by the following equation:

$$K = \frac{1}{1+a\ (t-20)}$$

where:

t -- measurement temperature (0°C)

a -- heat resistance factor.

The heat resistance factor for soft copper wire is 0.00393.

The rated value for actual capacitance of matrix-quad lines is 50.5 nF/km. The maximum value for actual capacitance does not exceed 57.5 nF/km. In practice, the average value for actual matrix-quad lines falls between the range 49 to 50 nF/km, the minimum value for actual capacitance is 47.2 nF/km, and the maximum value is 52.2 nF/km.

The values for capacitance unbalance in the quads (k_1) for a section length of cable equal to 600 m should not be greater than 500 pF. For 10% of the measurements, but not less than one measurement, the capacitance unbalance may not be greater than 1,000 pF. For cable segments lengths (L) of manufactured cable different from (L_0), the maximum value for capacitance unbalance is calculated by multiplying the value of the length L_0 by:

$$1/2\left(\frac{L}{L_0} + \sqrt{\frac{L}{L_0}}\right),$$

if the length L is greater than 300 m. With lengths L less than 300 m, the value for capacitance unbalance is calculated by taking L = 300 m.

Measurements carried out on more than 10 but less than 20 segments of manufactured cable have demonstrated that the capacitance unbalance (k_1) has not exceeded 400 pF/1,809 m, and its average value did not exceed 130 pF/1,809 m.

At 50 Hz, the insulation holds up without breakdown for the period of one minute at the following test alternating voltages:

2,000 V -- between a grounded shield and the core conductors connected among themselves;

750 V -- between all core conductors a and b connected between themselves, and all core conductors c and d connected between themselves and the shield and the ground.

The insulation resistance for each core conductor in the finished cable, relative to the length of 1 km, with respect to the other core conductors connected between themselves and with the shield, is at least 5,000 MΩ. In practice, the insulation resistance is at a level of 10^5 MΩ·km.

The actual component of line wave impedance at a frequency of 800 Hz is 370 Ω, and wave attenuation is 0.8 dB/km.

Design and construction solutions for local telecommunications cable with layers of insulation and a polyethylene jacket having an antimoisture barrier,

as well as the method of manufacturing it and its technical features are in accordance with actual worldwide achievements in this technical area.

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